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civil air navigation services organisation

Measuring Operational Environmental Performance

[Guidance Document]

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Guide to Measuring Operational Environmental Performance

1 Introduction

There is an increasing focus in the world today on climate change and the human activities which influence it. CANSO believes that air traffic management needs to do its part to reduce aviation's impact on the environment.

One of CANSO's key priorities is to improve aviation sustainability and environmental performance in the delivery of air traffic management services.

A key goal to achieve this is to encourage air navigation service providers (ANSPs) to measure their operational environmental performance and set ambitious goals for improvement.

CANSO has agreed a global ATM environmental efficiency target for 2050 of reducing CO_2 emissions by 4%, and many CANSO members have already adopted targets to improve their own environmental performance and have systems in place to achieve this. CANSO's aim is that all our members fully embrace the environmental challenge.

1.1_The Role of Metrics and Performance Indicators

Simply put, you can't manage what you don't know. In CANSO, our aim is to encourage all ANSP's to better understand their environmental performance to provide a platform for improvement.

Performance indicators provide a method of measuring an organisation's performance and enable internal or external comparison to monitor improvement.

1.2_Purpose of this Guide

The key audience for this guide is air navigation service providers (ANSPs) who want to understand, measure and improve operational environmental performance.

The guidance suggests appropriate measures for CO_2 emissions, noise and local air quality as these performance areas are best understood and documented at the time of writing. The guidance will be reviewed and updated as necessary to reflect further developments in scientific understanding or operational practice.

The guidance focuses on Key Performance Indicators (KPIs). However, the division of responsibilities between ANSP's, airport operators, regulators and airlines varies from one state to another so this guidance should be used as an indicative guide which may need to be adapted to local circumstances.

To support the division of responsibilities, CANSO recognises the importance of 'Collaborative Environmental Management' (CEM) as an effective tool for implementing a process that allows partnership between aviation stakeholders (airport and aircraft operators) in order to address environmental measures covered in this document.

For further information on CEM, [1]EUROCONTROL has developed guidance material to assist operational stakeholders.

Non-operational ANSP environmental performance such as employee activity, travel habits, waste production, energy consumption and influence over airport operators environmental performance may also be appropriate areas for performance targets to be considered. These however are not included in the scope of this document.

1.3_Targets

Environmental targets may be set against performance indicators to drive an organisation towards a common goal. They are an important component of any environment management system with which ANSPs use to continuously improve their environmental performance.

This document does not recommend specific targets for ANSPs; however the CANSO Environment Workgroup will continue further investigation with the intention or recommending targets in the future.

[1] http://www.eurocontrol.int/environment/gallery/content/publicdocuments/CEM_final_17%2011%2008.pdf

2
Climate Change

2.1_Overview

Through the burning of fuels such as Jet-A (turbine aircraft) or Avgas (piston aircraft), aviation releases gases and particles into the upper troposphere and lower stratosphere where they have an impact on atmospheric composition. These gases and particles modify the concentration of atmospheric greenhouse gases, including carbon dioxide CO_2), ozone (O_3), and methane (CH_4); and trigger formation of condensation trails (contrails which may contribute to climate change.

Airlines, manufacturers, ANSPs and airports are fully committed to reducing aviation's climate change impact and to contribute to finding a global solution. United under a common industry programme, industry associations ACI, CANSO, IATA and ICCAIA, under the umbrella of the Air Transport Action Group (ATAG) they share a joint commitment to a pathway to carbon-neutral growth and aspiring to a carbon-free future.

2.2_Aircraft Emissions Metrics

Aviation's impact on climate change is measured by industry on an analysis of fuel use[2] and CO_2 reduction potentials in four key areas:

1. Technology development
2. Air traffic management and infrastructure
3. Efficient operations
4. Economic/market-based measures

In its publication[2], 'ATM Global (Environmental Efficiency Goals for 2050) CANSO measured optimum routing/fuel efficiency as a means to develop aspirational goals for the reduction of global aviation CO_2 emissions.

ATM's contribution to reducing climate change can best be achieved by increasing fuel efficiency for aircraft using the ATM system.

100% Efficiency represents aircraft flying point to point via the optimum trajectory such as the great circle ground track route at the most fuel efficient altitude and speed.

A flight that uses 2% more fuel than the optimum trajectory is considered 98% efficient.

In practice, 100% efficiency is not possible for a number of reasons such as safety, (i.e. the need to keep aircraft separated by a certain distance or time), weather, capacity, and noise, all of which can be considered as interdependencies.

ATM efficiency improvements may be achieved by introducing a range of initiatives. Some of these can be directly introduced by ANSPs, such as new operating procedures. However, many rely on other participants in the aviation system, such as institutional change to reduce airspace fragmentation.

A common misconception is that the shortening of routes across the great circle route may result in the most efficient track for an aircraft flying between two points. However, initiatives such as Flex Track Routes, Continuous Descent Approach, Required Navigation Performance Approach and Departure Procedures have resulted in greater efficiency even though track miles flown may increase.

Significant improvements rely on the full collaboration between all aviation stakeholders, including States, in order to reduce the negative impact of the airspace interdependencies as well as the political fragmentation of global airspace.

Modernisation programmes such as the Single European Sky/SESAR and NextGen are examples of the institutional and technical restructuring required to deliver optimised airspace efficiency.

2.3_International Standards - ICAO

ICAO has formed the Group on International Aviation and Climate Change (GIACC). GIACC has been tasked to prepare an aggressive Plan of Action

[2] www.enviro.aero/WhatWeAreDoing.aspx
www.canso.org/xu/document/cms/streambin.asp?requestid=603FD1CA-6CDB-44D4-B75C-5FDF8A1E54D4

with goals and targets to address aviation's impact on climate change. The intention is for ICAO to provide this input to the climate change negotiations at the UNFCCC Copenhagen Conference of the Parties in December 2009.

The Committee on Aviation Environmental Protection (CAEP), without having any regulatory function, reports to the ICAO Council on Technical and Policy matters.

2.4_Regional Standards – Europe

Recognising that aviation increasingly contributes to global climate change, the European Parliament and the Council of the European Union published in January 2009 the directive 2008/101/EC to include aviation in the [3]EU Emissions Trading Scheme.

In addition, SESAR, the European ATM infrastructure modernisation programme, is an ambitious and comprehensive attempt to drive and coordinate ATM initiatives such as airspace design, improved in-flight and ground operations. Within SESAR, ambitious environmental goals and measures are defined.

Environmental performance is addressed too in the Functional Airspace Blocks (FAB) initiatives in Europe aiming at de-fragmenting the ATM in Europe.

The Flight Efficiency Plan is a joint initiative launched by Eurocontrol, IATA and CANSO in September 2008 to drive immediate efficiency improvements. The five action points of the Flight Efficiency Plan are:

1. Enhancing European en-route airspace design,
2. Improving airspace utilisation and route network,
3. Efficient TMAs design and utilisation,
4. Optimising airport operations,
5. Improving awareness on performance.

The implementation of the improvements is expected to bring benefits of approximately 1.5MtCO_2 per year, which equates to just over 1% improvement over the 2005 baseline for Europe. The Flight Efficiency Plan indicates that the greatest benefit is in improved airspace utilisation, in the terminal area / airport operations and goes on to say that ATM on its own can achieve little.

2.5_Regional Standards – United States

NextGen is a wide ranging transformation of the entire US air traffic management system. It will replace ground-based technologies with new and more dynamic satellite based technology and a collaborative effort between the FAA and partners from the airports, airlines, manufacturers and other government and industry stakeholders.

The objective is to establish the most cost-effective approach to reducing significant impact of aviation emissions in absolute terms, while enabling the future air traffic system to handle growth in demand.

NextGen will reduce aviation's environmental footprint through a combination of enhanced air traffic procedures, improvements in environmental technologies for aircraft and engines, introduction of sustainable alternative fuels, and use of an environmental management system to make continual improvements in environmental protection. The efficiencies that reduce delays also save fuel and reduce emissions.

To achieve this, the FAA have set a Performance Target towards reaching environmental efficiency; *'Improve aviation fuel efficiency per revenue plane-mile by 1 percent each year through FY2011, as measured by a three-year moving average, from the three-year average from calendar years 2000-2002'*. (As documented in the FAA Flight Plan).

2.6_Regional Standards – Asia Pacific

Asia and South Pacific Initiative to Reduce Emissions[4] (ASPIRE) is a partnership between the Federal Aviation Administration (FAA), Airservices Australia, Airways New Zealand, Japan Civil

3 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:008:0003:0021:EN:PDF
4 http://www.aspire-green.com.

Aviation Bureau (JCAB) and Civil Aviation Authority of Singapore (CAAS) with a focus on developing ideas that contribute to improved environmental standards and operational procedures in aviation.

ASPIRE aims to raise industry's environmental performance in reducing fuel burn and carbon dioxide emissions.

A series of flights have taken place from New Zealand and Australia to Los Angeles and San Francisco using fuel efficient procedures which have demonstrated savings of many tons of CO_2 emissions, making use of fuel efficient ATM procedures such as;

- priority clearance from air traffic control for taxiing and departure;
- unimpeded climb through to cruise altitude;
- allowing aircraft to reach its optimum cruise altitude as quickly and efficiently as possible;
- a user preferred route for the most efficient path taking into account winds and aircraft weight;
- real time updates of current weather and wind conditions that allow the flight crew to modify their flight path;
- tailored arrival procedures.

2.7_Measuring ATM Performance

ATM's contribution to reducing climate change can best be achieved by increasing fuel efficiency for aircraft using the ATM system.

ATM Efficiency Improvements

ATM efficiency improvements are possible by moving towards fuel optimal flight procedures within the bounds of the current interdependencies. Improvements are also possible by reducing the effect of the interdependencies such as increasing capacity and reducing noise restrictions etc.

Fuel Burn

To establish the baseline, ANSPs can examine fuel burn and estimate the amount of fuel burnt in excess of that required to fly the most optimum point to point great circle route.

Consolidated fuel burn data gathered from a range of potential sources can be converted into equivalent CO_2 emissions using emission indices. A conversion rate of 3.15 is commonly used so that for every 1.0 kg of fuel burned, 3.15 kg CO_2 are emitted.

For domestic traffic, by calculating an increase or decrease in fuel burn across an ANSPs total network over a period of time, an ANSP can determine the corresponding CO_2 emissions and set ATM Performance Indicators to influence this.

To assess the impact of improvement measures for air traffic guided through airspace of several ANSPs the assessment method may differ. Indeed, the determining parameter is emissions produced during the whole of the flight from the departure to the destination airport, where the flight may pass the airspace of several ANSPs.

Improvements in an ANSPs airspace design or operational procedures leading to a global reduction of emissions, can imply an increase in emissions for one or more of the ANSPs, and a reduction for one or more other ANSPs.

Therefore for measures taken by an ANSP that not only impact the portion of flight within the ANSP, other assessment methods should be applied. For example, for a change in airspace design or operational improvements affecting not only the flight path within the ANSP, the impact for all the flights subject to the change should be assessed.

2.8_Recommendations

CO_2 Performance Indicators

There are no exact models for calculating the impact air navigation services have on climate change; however ANSPs can establish performance indicators around a number of operational measurements.

Global Performance Indicators
1. Total annual CO_2 for all [Named ANSPs] airspace
2. Total annual CO_2 for [Named ANSPs] domestic airspace
3. Total annual CO_2 for [Named ANSPs] ground operations at airports where a control service is provided
4. Total CO_2 for (Named ANSPs) in En Route airspace 40nm from departure to 100nm on arrival
5. Total CO_2 emissions attributed to terminal area delay absorption thru S-turns, airborne holding / trombone (includes excess lateral movement/time in descent phase)*
6. Vertical profile on descent
7. Average CO_2 per flight in domestic airspace and on the ground at airports
8. Total annual CO_2 for all [Named ANSPs] [domestic] airspace per flight en-route
9. Total annual CO_2 for [Named ANSPs] [domestic] airspace per Kilometre flown en-route
10. Total annual CO_2 for [Named ANSPs] [domestic] airspace per Kilometre of the total [Named ANSPs] network en-route
11. Annual average CO_2 at [Named ANSPs] [Name] airport per Kilometre of airport taxiway
12. Annual Average CO_2 per flight from gate to gate (en-route and LTO cycle)

*considering excess from one hundred miles and in is consistent with FAA/EUROCONTROL method.

Besides global performance indicators, more tailored performance indicators can be used, to monitor the performance of individual measures. For example Continuous Descent Operations (CDO) Performance Monitoring may include, as appropriate:

Performance Indicators For Specific Measures (CDO)
1. Number of airports adopting CDO (ANSP-wide)
2. Number of airlines participating in CDO (ANSP-wide and per CDO airport)
3. Percentage of flights achieving CDO (ANSP-wide and per CDO airport)
4. Percentage of time after Top of Descent being flown as CDO (ANSP-wide and per CDO airport)
5. Percentage of Track Miles (after Top of Descent) being flown in level flight (ANSP-wide and per CDO airport)
6. Estimated fuel and emissions being saved by CDO (ANSP-wide and per CDO airport)
7. Difficulties and Successes experienced in implementing CDO

EXISTING ATM PERFORMANCE GOALS

The Advisory Council for Aeronautics Research in Europe (ACARE) was set up in 2001 by EU Aviation stakeholders to provide guidance on how to address new challenges.

The goals set for 2020 are to reduce by 50% CO_2 emissions per passenger-kilometre and 80% in NO_x emissions relative to year-2000 aircraft. In terms of CO_2 reduction, ATM should contribute to a 5 to 10% level the rest being allocated to airframe and engine improvements).

As discussed previously, CANSO has established a global ATM environmental efficiency target for 2050 of reducing CO_2 emissions by 4%.

3 Aircraft Noise

3.1_Overview

Aircraft Noise is the sound produced by any aircraft or its components whilst on the ground, while parked using auxiliary power units; while taxiing; on run-up from propeller and jet exhaust; during take off; underneath and lateral to departure and arrival paths, over-flying while en route or during landing.

In general, the greatest noise levels are experienced closest to the airport, however disturbance can also occur many miles away under aircraft approach and departure routes.

To effectively manage and monitor the impact aircraft noise has on an airport; systems are implemented to record the identity, flight path and altitude of each aircraft operating to and from an airport, the noise levels produced by individual aircraft, weather data, and the general background noise.

Typically, the information collected is used to:

- determine the contribution of aircraft to overall noise exposure
- detect occurrences of excessive noise levels from aircraft operations
- assess the effects of operational and administrative procedures for noise control and compliance with these procedures
- assist in planning of airspace usage
- validate noise forecasts and forecasting techniques
- assist relevant authorities in land use planning for developments on areas in the vicinity of an airport , and
- generate reports and provide responses to questions from Government, industry organisations, community groups and individuals.

3.2_Noise Metrics

Aircraft Noise can be assessed using a number of metrics. The factors taken into account may include the level of the noise, its frequency content, its variability over a period of time, and the time of day at which it occurs.

Most noise measurements are given in terms of dBA, which means the A-weighted sound level. For aircraft noise certification purposes, a more elaborate method is used, and the noise level metric is the EPNdB – Effective Perceived Noise Level.

A summary of the more commonly encountered metrics applied to aircraft noise are:

Maximum Noise Levels (LAmax, PNLmax)

The noise level is assessed in terms of the instantaneous maximum sound level that is reached during an overflight.

Noise Event Levels (SEL, EPNL) A measure that combines the sound level and its duration is the Sound Exposure Level (SEL), which assesses the total noise energy from the overflight, not just the maximum instantaneous level. The SEL will normally be numerically greater than the LAmax. Effective Perceived Noise Level (EPNL) s mainly used for certification purposes and is a complex, single number metric which approximates human annoyance responses. It includes correction terms for the duration of an aircraft flyover and the presence of audible pure tones of discrete frequencies (such as the whine of a jet aircraft) in the noise signal.

Statistical Sound Level (Ln) A metric often used to describe noise levels that vary over time, e.g. a L95 gives the noise level which is exceeded 95% of the time during a certain time interval and will give a background sound level which is interspersed with the higher levels of aircraft overflight.

Average Noise Levels (ANEF, ANEI, Leq, Ldn, Lden) Varying noises are expressed in terms of the average noise level over a period of time. For aircraft applications, these averages are normally determined over the full 24 hours of a day and may be additionally determined for periods of the day, e.g. for the night-time or the daytime.

A Noise Exposure Forecast (NEF) is applied to aircraft noise only and is derived from the more elaborate PNL-type measurements referred to above. It includes a penalty loading (in dB) for aircraft movements occurring within restricted times and is often used for compatible land use planning around airports.

Leq, Ldn and Lden may be applied to all types of environmental noise. Leq or the equivalent noise level is the average energy metric over a period of time. In aviation the A-weighed Leq is used. Parameters like Ldn, the day night level, and Lden, give weighted Leqs over a 24hour period, but with a penalty of 10 decibels for night noise and for the Lden additionally a 5 decibel penalty for the evening period.

Others: Time above a given level (TAxx) may also be quantified in terms of the time, in minutes per day, during which the noise level due to aircraft will be greater than a given level. Number of Exceedances of a given level (Nxx) quantifies the number of times that a given noise level is exceed in a day.

3.3_International Standards - ICAO

In 2001, the ICAO Assembly endorsed the concept of a “balanced approach” to aircraft noise management ([5]Appendix C of Assembly Resolution A35-5).

Much of ICAO’s effort to address aircraft noise over the past 30 years has been aimed at reducing noise at source. Aircraft built today are required to meet noise certification standards adopted by the Council of ICAO.

ICAO does not mandate specific metrics to measure aircraft noise nor have they produced guidance on the creation of key performance indicators for ANSPs seeking to play their role.

3.4_Regional Standards - Europe

In 2002, the European Parliament and the Council of the European Union set out a directive (2002/49/EC) relating to the assessment and management of environmental noise. The directive acknowledges a development of a common noise indicator and a common methodology for noise calculation and measurement around airports as identified in the Commission Communication of 1 December 1999 on Air Transport and the Environment.

Typically, a Sound Exposure Level (SEL) is used to describe the amount of noise from an event such as an individual aircraft flyover. It is computed from measured dBA sound levels and the integration of all the acoustic energy contained within the event. SEL form the base metric for calculation of noise contours, Noise contours to be calculated as a minimum are:

[5] http://www.icao.int/icao/en/env/a35-5.pdf

- Lden contours, calculated for an annual period.
- Leq- contours for the 8-hour night period calculated for an annual period

3.5_Regional Standards – The United States

The Federal Aviation Administration (FAA) determined that cumulative noise energy exposure of individuals resulting from aircraft activities must be established in terms of day-night average sound level (DNL) and that DNL 65 decibels (dB) is the threshold of significant noise impact. The FAA determination was further supported by a report issued by the Federal Interagency Committee on Noise (FICON) in August 1992. The FICON report concluded that DNL is the recommended metric and should continue to be used as the primary metric for aircraft noise exposure. The FICON also concluded that the use of individual supplemental metrics to analyse noise should remain at the discretion of individual agencies.

The areas of DNL 65 dB and higher are normally within an Airport environment and therefore rest within the jurisdiction of the FAA Airports Division. According to the 1992 FICON report, examination of noise levels between DNL 65 and 60 dB should be done if screening shows that noise sensitive areas at or above DNL 65 dB will receive an increase in noise of 1.5 dB or more. Also, that further analysis should be completed to identify noise sensitive areas between DNL 65 and 60 dB that have an increase of DNL 3 dB or greater. The DNL 3 dB analysis is only completed when a DNL 1.5 dB increase is documented within the DNL 65 dB contour. Although the threshold of significance is DNL 65 dB, the environmental studies conducted by the Airports Division usually extend out to the DNL 60 dB contour and address changes in the airport layout, they may include some proposed modifications to air traffic procedures specifically for noise abatement.

The areas outside of the DNL 65 dB contour are included in environmental studies related to projects involving changes in air traffic and/or procedures by the FAA's Air Traffic Organization (ATO). These projects are analysed for noise impacts from the DNL 65 dB out to the DNL 45 dB threshold. In keeping with the 1992 FICON recommendation, the increments of analysis focus on the DNL 3 dB and DNL 5 dB areas of change. The current policy for the FAA ATO is that supplemental noise analysis is required to determine aircraft noise exposure for changes of DNL 3 dB within the DNL 65 to 60 dB area, and changes of DNL 5 dB within the DNL 60 to 45 dB areas. The areas of change in an ATO environmental analysis are generally shown in a grid analysis format rather than by contours.

3.6_Regional Standards – Australia

Mandated by government and local legislation, Australia uses the Australian Noise Exposure Forecast (ANEF) as a scientific measure of the aircraft noise exposure levels around airports. Noise exposure levels are calculated in NEF units, which take into account the following factors of aircraft noise:

- The intensity, duration, tonal content and spectrum of audible frequencies of the noise of aircraft take offs, approaches to landing, flyover and reverse thrust after landing.
- The forecast frequency of aircraft types and movements on the various flight paths, including flight paths used for circuit training.
- The average daily distribution of aircraft arrivals and departures in both day-time and night-time (day-time: 07:00am and 07:00pm / night-time: 07:00pm and 07:00am).

3.7_Measuring Noise Performance

Responsibility for aircraft noise management, whether it be the ANSP, Regulator or an airport owner varies significantly around the world.

Despite the disparity in who is ultimately responsible, ANSPs can play an active role in influencing noise exposure as exampled by;

1. Designing Routes that take into account population density, hospitals and schools. Then closely monitoring aircraft route adherence during operation if noise concentration is preferred (dispersion is also an option).
2. Implementing Take-off and Landing Procedures and Techniques that lower the noise emitted by the aircraft or its effect. For example, Continuous Descent Approach, Steeper Approach, Precision Approach and Departure Procedures or dispersed dispersions (dependent on local policy), noise abatement departure procedures, choice of the Runway in use and displaced thresholds.
3. Monitoring Change to Noise Contours by establishing a baseline and monitoring the changes day to day operations have on the contour allowing an ANSP to establish performance indicators that seek to reduce the impact its operations have on the local environment.
4. Monitoring Deviations from Standard Operations by measuring percentage deviations from noise preferential runways and routes as well developing more generic operational performance statistics on variations to procedural operations such as ATC direct routing or flight receiving optimum climb profiles. This provides an ANSP with a good indicator as to how its operations may impact the local environment.

3.8_Recommendations

ATM Noise Performance Indicators

There are no exact models for calculating the impact air navigation services have on aircraft noise; however following performance indicators may be used by ANSPs seeking to improve their influence on the impact aircraft noise has on the environment:

Existing ATM Performance Goals

The Advisory Council for Aeronautics Research in Europe (ACARE) was set up in 2001 by EU Aviation stakeholders to provide guidance on how to address new challenges.

For 2020, ACARE has set noise reduction targets to reduce perceived noise by half and eliminate noise nuisance outside airport boundaries. This means respectively -10 EPNdB / Operation and 65 LDEN at Airport Boundaries.

4
Local Air Quality

4.1_Overview

Air is mainly nitrogen and oxygen, with smaller proportions of inert gases and carbon dioxide. Aviation adds other components to the atmosphere, which can be harmful to people’s

Global Performance Indicators
1. Number of Percentage of deviations from noise preferential / noise abatement routes.
2. Total and Percentage of flights receiving optimum climb profile per airport
3. Percentage change to noise contour (in area e.g. Km^2)
4. Calculating the No. of people in an area/population within noise contour

health and result in ‘air pollution’ or degraded ‘air quality’ near airports. The most important aircraft emissions are nitrogen oxides (NOx), volatile organic compounds (VOCs), carbon monoxide (CO) and particulate matter (PM_{10} and $PM_{2.5}$).

At airports in particular, there are also non-aircraft pollution sources related to other forms of transport and facilities, making it difficult to determine the actual effect of airport-induced emissions on the environment.

To address the health concerns legislators have developed framework directives on ambient air quality assessment, however, it is difficult to estimate the airport-related pollution by monitoring the ambient air quality alone. Therefore, estimating the contribution of aviation sources relative to a local pollution can only be achieved by modelling.

At the local level, airports work alongside local partners and stakeholders to assess the impact of airport emissions on local air quality, and to develop management strategies and plans, however the role ANSPs play in monitoring their own performance is limited.

4.2_Local Air Quality Metrics

ICAO has set engine certification standards in the convention on International Aviation (Annex 16 Volume 2) that limit the emissions of unburned hydrocarbons, NO_X, CO and smoke during the landing and take-off (LTO) cycle, up to an altitude of 3,000 feet agl.

The LTO cycle includes idle, taxi, take-off, climb out, descent and approach. Local air quality at ground level remains largely unaffected by aircraft emissions that take place above 3,000 feet agl because dispersion reduces concentration levels for these emissions.

Unlike with noise, there are currently no internationally accepted standards for computing aircraft emissions.

Two overall types of quantification are required:

Measurement, sampling the local air and analysing for NO_X, particulates and other important pollution species. The sampling is often done on a 24 hour continuous basis.

Modelling, creating an inventory for all significant emitters linked to the airport in a sophisticated model to predict with reasonable accuracy, the degree of contribution of the airport to local pollution levels and what the dispersion patterns are.

When combined with measurement, and estimates of airport growth and the anticipated changes to third party emissions, an estimate of current and future emissions levels can be determined.

ICAO has defined the following metrics:

Dp/Foo: The mass, in grams (Dp), of any pollutant emitted during the reference landing and take-off (LTO) cycle, divided by the rated output (Foo) of the engine.

Emissions index (EI): The mass of pollutant (CO, HC or NOx), in grams, divided by the mass of fuel used in kilograms.

Smoke Number (SN): The dimensionless term quantifying smoke emissions. Smoke Number is calculated from the reflectance of a filter paper measured before and after the passage of a known volume of a smoke-bearing sample.

Regulatory Level: The level below which the characteristic Dp/Foo or Smoke Number value for a pollutant species must fall in order to obtain certification approval.

All of these can contribute to reducing air quality related emissions, whilst at the same time delivering other economic and climate change benefits. For operational measures however, there may also be trade-offs with capacity and noise, and a full assessment needs to be made before adoption.

4.3_International Standards - ICAO

ICAO Annex 16, Volume II to the Chicago Convention regulates aircraft engine emissions of NOx, CO, hydrocarbons and smoke, for a reference LTO cycle below 3,000 feet.

ICAO has also published guidance's on emissions :

- 'Guidance on Aircraft Emission Charges Related to Local Air Quality (Doc 9884) – that is, charges or taxes.
- 'Operational opportunities to minimize fuel use and emissions' (ICAO Circ. 303, AN 176)

4.4_Regional Standards - Europe

In 2008 the European Parliament and the Council of the European Union set out a Directive on Ambient Air Quality and Cleaner Air for Europe (Directive 2008/50/EC) which sets standards and target dates for reducing concentrations of fine particles, which together with coarser particles known as PM10 already subject to legislation, are among the most dangerous pollutants for human health.

4.5_Regional Standards – The United States

The Emissions and Dispersion Modelling System (EDMS) was developed in the mid-1980s as a complex source microcomputer model designed to assess the air quality impacts of proposed airport development projects.

Emissions are computed against US FAA's AEDT System for assessing Aviation's Global Emissions [6] AEDT (SAGE).

4.6_Measuring ATM Performance

Responsibility for managing the local air quality around an airport does not typically fall to the ANSP, as it is usually left to the airport to manage under the local environment protection authority or legislation.

Despite the limited role ANSPs play in managing their own business to meet local air quality standards, ANSPs can play an active role in limiting the impact aircraft has on the environment.

The following measures are used to address emissions below 1000 ft:

- Low fuel/emission aircraft departure procedures;
- Continuous Descent Approach and Low Power - Low Drag techniques;
- Avoiding aircraft queuing on the ground;
- Taxiing management (e.g. towing and single engine taxi);
- Take-Off and Landing supported with Departure and Arrival Management Systems; Surface Movement Guidance and Control System.
- Measuring the percentage of flights receiving optimum climb profiles per airport allows an ANSP to understand the positive impact its operations have on the environment.

Responsibilities during landing and take-off are shared between airport, aircraft operators and ANSPs however collaborative environment management tools are commonly used by stakeholders to allow a consistent approach to LAQ issues.

4.7_Recommendations

ATM PPerformance Indicators

As yet there is no exact model for calculating the impact air navigation services have on local air quality; however ANSPs can establish performance indicators around a number of operational measurements.

Global Performance Indicators
Percentage or number of flights receiving optimum climb profiles per airport
Percentage or number of flights receiving optimum descent profiles per airport
Number of aircraft queuing on the ground

[6] http://www.faa.gov/about/office_org/headquarters_offices/aep/models/edms_model/

5
Summary

This paper suggests environmental KPIs and metrics for use by CANSO members. It focuses on CO_2 emissions, Noise and Local Air Quality.

Generally, ANSPs are most experienced in monitoring and tracking noise impacts and, for some air quality has also been an important factor especially for ANSPs who also have an airport management remit. For many, the measurement and management of CO2 emissions is a relatively new area. Consequently data and methodologies to calculate fuel burn and CO2 emissions are still evolving. There are however some notable areas of expertise among CANSO's members and we have attempted to highlight these as potential starting point for other ANSPs wishing to develop their emissions reporting and management capabilities.

The most common operational metric recorded by states is that of delay measurement. Although not strictly an environmental metric, ground and airborne delay can be used as crude measures of potential to effect local air quality and emissions respectively.

CANSOs Global CO2 benchmark encourages ANSP's to monitor their local contribution to CO2 emissions as a localised approach towards reducing their impact on climate change. Further work is to be done, however ongoing commitment by CANSO and its members help improve the accuracy of CANSO's calculation of the global ANSP contribution to CO2 emissions

Work is ongoing within ICAO on the issues of Aviation related climate changing emissions. The implementation of the European Emissions Trading Scheme (EU-ETS) together with continued work by ACARE is intended to provide mechanisms to drive improvements in emissions performance. No common mechanism for recognition of these improvements has yet been identified.

How can CANSO Help?

CANSO is committed to improving ATM operational and environmental performance. CANSO provides a global forum for the ATM industry to debate and agree on global solutions to our key issues and to establish industry goals.

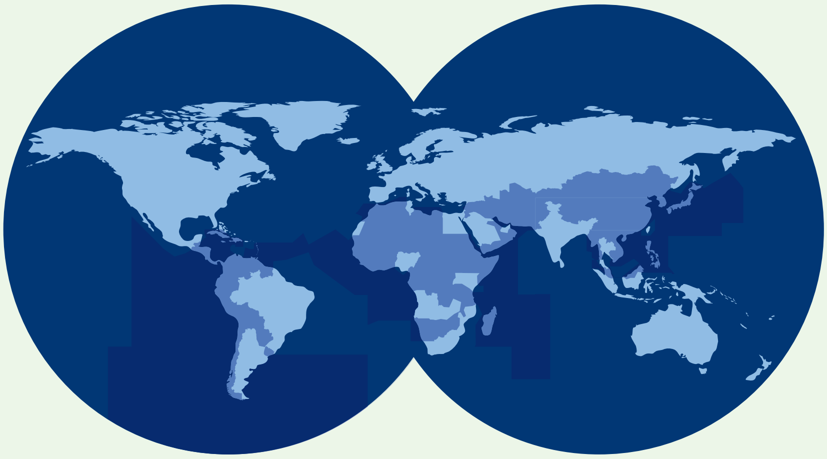
CANSO also offers practical assistance and guidance to improve ATM environmental performance.

The CANSO Environment Workgroup is continuing to look at ways to assist ANSPs manage environmental performance. For more documents, visit our website www.canso.org/environment.

CANSO Members

CANSO – The Civil Air Navigation Services Organisation – is the global voice of the companies that provide air traffic control, and represents the interests of Air Navigation Services Providers worldwide.

CANSO members are responsible for supporting over 85% of world air traffic, and through our Workgroups, members share information and develop new policies, with the ultimate aim of improving air navigation services on the ground and in the air. CANSO also represents its members' views in major regulatory and industry forums, including at ICAO, where we have official Observer status. For more information on joining CANSO, visit www.canso.org/joiningcanso.



Lighter areas represent airspace covered by CANSO Members

Full Members - 78

— Aeronautical Radio of Thailand (AEROTHAI)
— Aeroportos de Moçambique
— Air Navigation and Weather Services, CAA (ANWS)
— Air Navigation Services of the Czech Republic (ANS Czech Republic)
— Air Traffic & Navigation Services (ATNS)
— Airports and Aviation Services Limited (AASL)
— Airports Authority of India (AAI)
— Airports Fiji Limited
— Airservices Australia
— Airways New Zealand
— Angkasa Pura I
— Austro Control
— Avinor AS
— AZANS Azerbaijan
— Belgocontrol
— Bulgarian Air Traffic Services Authority (BULATSA)
— CAA Uganda
— Civil Aviation Authority of Bangladesh (CAAB)
— Civil Aviation Authority of Botswana
— Civil Aviation Authority of Singapore (CAAS)
— Civil Aviation Regulatory Commission (CARC)
— Department of Airspace Control (DECEA)
— Department of Civil Aviation, Republic of Cyprus
— DFS Deutsche Flugsicherung GmbH (DFS)
— Dirección General de Control de Tránsito Aéreo (DGCTA)
— DSNA France
— Dutch Caribbean Air Navigation Service Provider (DC-ANSP)
— ENANA-EP ANGOLA
— ENAV S.p.A: Società Nazionale per l'Assistenza al Volo
— Entidad Pública Aeropuertos Españoles y Navegación Aérea (Aena)
— Estonian Air Navigation Services (EANS)
— Federal Aviation Administration (FAA)
— Finavia Corporation
— GCAA United Arab Emirates
— General Authority of Civil Aviation (GACA)
— Hellenic Civil Aviation Authority (HCAA)
— HungaroControl Pte. Ltd. Co.
— Israel Airports Authority (IAA)
— Iran Airports Co
— Irish Aviation Authority (IAA)
— ISAVIA Ltd
— Japan Civil Aviation Bureau (JCAB)
— Kazaeronavigatsia
— Kenya Civil Aviation Authority (KCAA)
— Latvijas Gaisa Satiksme (LGS)
— Letové prevádzkové Služby Slovenskej Republiky, Štátny Podnik
— Luchtverkeersleiding Nederland (LVNL)
— Luxembourg ANA
— Maldives Airports Company Limited (MACL)
— Malta Air Traffic Services (MATS)
— NATA Albania
— National Airports Corporation Ltd.
— National Air Navigation Services Company (NANSC)
— NATS UK
— NAV CANADA
— NAV Portugal
— Naviair
— Nigerian Airspace Management Agency (NAMA)
— Office de l'Aviation Civile et des Aeroports (OACA)
— ORO NAVIGACIJA, Lithuania
— PNG Air Services Limited (PNGASL)
— Polish Air Navigation Services Agency (PANSA)
— PIA "Adem Jashari" - Air Control J.S.C.
— PT Angkasa Pura II (Persero)
— ROMATSA
— Sakaeronavigatsia Ltd
— S.E. MoldATSA
— SENEAM
— Serbia and Montenegro Air Traffic Services Agency (SMATSA)
— Serco
— skyguide
— Slovenia Control
— State Airports Authority & ANSP (DHMI)
— State ATM Corporation
— Tanzania Civil Aviation Authority
— The LFV Group
— Ukrainian Air Traffic Service Enterprise (UkSATSE)
— U.S. DoD Policy Board on Federal Aviation

Gold Associate Members - 14

— Abu Dhabi Airports Company
— Airbus ProSky
— Boeing
— BT Plc
— FREQUENTIS AG
— GE Air Traffic Optimization Services
— GroupEAD Europe S.L.
— ITT Exelis
— Lockheed Martin
— Metron Aviation
— Raytheon
— SELEX Sistemi Integrati S.p.A.
— Telephonics Corporation, ESD
— Thales

Silver Associate Members - 62

— Adacel Inc.
— ARINC
— ATCA – Japan
— ATECH Negócios em Tecnologia S/A
— Aviation Advocacy Sarl
— Avibit Data Processing GmbH
— Avitech AG
— AZIMUT JSC
— Barco Orthogon GmbH
— Booz Allen Hamilton, Inc.
— Brüel & Kjaer EMS
— Comsoft GmbH
— CGH Technologies, Inc
— Abu Dhabi Department of Transport
— Dubai Airports
— EADS Cassidian
— EIZO Technologies GmbH
— European Satellite Services Provider (ESSP SAS)
— Emirates
— Entry Point North
— Era Corporation
— Etihad Airways
— Guntermann & Drunck GmbH
— Harris Corporation
— Helios
— Honeywell International Inc. / Aerospace
— IDS – Ingegneria Dei Sistemi S.p.A.
— Indra Navia AS
— Indra Sistemas
— INECO
— Inmarsat Global Limited
— Integra A/S
— Intelcan Technosystems Inc.
— International Aeronavigation Systems (IANS)
— Iridium Communications Inc.
— Jeppesen
— JMA Solutions
— LAIC Aktiengesellschaft
— LEMZ R&P Corporation
— LFV Aviation Consulting AB
— Micro Nav Ltd
— The MITRE Corporation – CAASD
— MovingDot
— New Mexico State University Physical Science Lab
— NLR
— Northrop Grumman
— NTT Data Corporation
— Project Boost
— Quintiq
— Rockwell Collins, Inc.
— Rohde & Schwarz GmbH & Co. KG
— RTCA, Inc.
— Saab AB
— Saab Sensis Corporation
— Saudi Arabian Airlines
— SENASA
— SITA
— STR-SpeechTech Ltd.
— TASC, Inc.
— Tetra Tech AMT
— Washington Consulting Group
— WIDE

Correct as of 11 April 2013. For the most up-to-date list and organisation profiles go to www.canso.org/cansomembers